XIV.

Forward the stout Macdonagh rush'd,
And Ow'ny close behind him push'd—
But what a yell of joy arose,
When in he poked his frosty nose!
What deaf'ning peals of loud huzzas,
From quiv'ring mouths and gaping jaws!
"Cead-Mille-Faltagh" roar'd aloud,
By every tongue in all the crowd!—
Now soon before the blazing fire,
He free'd himself from moss and mire,
And twinkt his eye, and gaily laugh'd,
As deep the meather-cup he quaff'd,
Which took its mirth-inspiring round,
Ere yet the board was spread;
And then no milk-sop dare be found,
To turn askew his head.
For such the practice I have seen;
And such the custom still I ween;
To take a swig of good potteen,
To make the stomach sharp and keen,
Before they tasted bread.

END OF CANTO FIRST.

ON RAILWAYS.

In the first Number of the Magazine, we laid before our readers a short article on railways; and adverted to the advantages that might probably result from their establishment, on an extensive scale, particularly in this country. In the remarks which we offered, we had no idea of recommending any measure that would interfere with the interests of any establishments, at present existing in this country: we merely recommended the formation of railways in districts which are at present destitute of any adequate means of internal communication; and we conceive that no subject can form a fairer ground for discussion. Every such discussion, indeed, if properly conducted, will tend, whatever views the writer may advocate, to throw additional light on the merits of the question, and to enable the public to judge how far the intentions of those who wish to introduce railways, are to be countenanced and supported. Companies and individuals, either caught with the novelty of the proposed measures, or influenced by prospects of emolument, may exaggerate the advantages to be derived from the plans in contemplation; while others, viewing the subject through a different medium, may be as decided in their opposition to the same measures, and may excite prejudices against them, in the minds of those who may have it in their power to advance or obstruct the intended projects. In England and Scotland, the most determined and systematic opposition has been given to the extension of railways, chiefly by those who are connected with canals, as they conceive that the new measures may interfere with their immediate interests; and we cannot be surprised, should a similar feeling manifest itself in this country. Should this be the case, we trust that all the proceedings and discussions will be conducted, on both sides, in a candid and decorous manner, and with due respect to the opinions of others.

The contrary case may excite bad feelings, and do harm in other respects, but can be of no service to either party; and it should always be recollected, that the ultimate and best arbiter is the public mind, which rarely errs when it has suitable information, and which will sooner or later form a just conclusion respecting the conduct and arguments of the parties concerned.

We shall now proceed to make some observations, which may tend to illustrate the subject still farther, and to show the grounds of some of the statements in our former article.

Few of our readers are perhaps aware, that railways have been used for the conveyance of waggons, drawn by horses, for the period of nearly 150 years. Such ways are said to have been first employed at the Newcastle collieries, about the year 1680, for the transporting of coals to the ships on the Tyne, and were made of beech. By means of these, a single horse could easily draw three tons; and, consequently, their use was attended with much advantage, though, from the nature of the wood, they were subject to frequent and expensive repairs. On account of this latter circumstance, flat bars of iron were afterwards fastened on the top of the wooden rails; and a still farther and most important improvement was the use of iron alone. Railways of this description, of various lengths, from a mile or less to nearly thirty, have been used, for a considerable period, in all the mining districts of Britain. They are also employed, in some places, as auxiliaries to canals, instead of locks, to enable lighters to pass on an inclined plane, from one level to another; and they are sometimes used in preference to canals. Neither is the idea of employing steam as the moving power on such roads a novel one; the late Mr. Edgeworth, of Edgeworthstown, having suggested it so early as the year 1802. Whether a like suggestion had been made before, we cannot state with certainty; but we are inclined to think it had not. Two years after, and consequently twenty-one years ago, a successful trial of the use of a high pressure locomotive steam-engine was made "on the Cardiff and Merthyr railway, where ten tons of iron, (long weight,) loaded on tram waggons, with the additional weight of about seventy persons, for great part of the way, were drawn for nine miles, at the rate of nearly five miles * per hour, by the use of one of these steam-engines, fixed on its own waggon, no supply of water for the boiler being found necessary for this distance." Here,

* In this article, and in the former on the same subject, English miles alone are employed. In like manner, when money is mentioned, British currency is understood.

in a first trial, if we include the weight of the men, we shall have fifteen or sixteen tons, (common weight,) besides the weight of the engine and the waggons, propelled with very considerable velocity. The account here given, indeed, is defective in two points; as we are not informed either as to the power of the engine, or the inclination of the road. For our present purpose, however, this is of no consequence; as our object, by these statements, is merely to show, that the measures in contemplation are by no means of that new or chimerical nature, that some imagine; but are only to be an extension of principles which have already been tried with success, and which it remained for the ingenuity and enterprise of the present time to render fully available in promoting the national prosperity.

With respect to the first expense of rail-roads, which we before stated to be from a half to a fourth of the expense of an ordinary canal, it is obvious that it, as well as the original cost of a canal, must be governed, in a great degree, by the nature of the country through which they pass, and by the purposes for which they are intended. We find, accordingly, that a railway—whether single or double, we are not informed—extending from the Hurlet coal and lime works to the Paisley canal, and employed for horses, cost £660 per mile; while the Liverpool and Manchester railway, constructed on a great scale, and fourfold, for locomotive engines, is estimated to cost £15,000 a mile. Dr. Anderson mentions £1000 per mile as the cost of a double railway for horses, in the most favourable situations; and for very stout ways, in the vicinity of London, where labour is dear, he supposes £3000 per mile to be requisite; and Mr. Buchanan says that, "where there are considerable embankments to form, bridges to build, and deep cuttings, the expense may rise to £4000 and £5000 per mile." In a series of ingenious papers in the *Scotsman*, it is estimated that a railway, destined to serve the purposes of a great national thoroughfare, for vehicles of all kinds, quick and slow, would cost at least from £6000 to £10,000 per mile, including the price of the ground. Now, let us contrast these with the expenses of forming canals, and we shall find the differences to be immense. The expense of the canal from Lough Neagh to Lough Erne, we are told, has been estimated at £3282 per mile; and we are informed in the *Scotsman*, that the Union Canal has cost altogether about £12,000 per mile; the Forth and Clyde, if executed now, would cost twice as much; and the Caledonian Canal will ultimately cost almost £50,000 per mile. Mr. Buchanan also asserts that "the first cost of a canal is three or four times

that of a railway;" and Mr. Stevenson, as quoted in the *Scotsman*, says that "the first expense of a canal will be found to be double, if not treble, the expense of a railway: such are the difficulties of passing through a well-cultivated country, and especially of procuring a sufficient supply of water in manufacturing districts, that four times the expense will, in most cases, be nearer the mark." It should also be stated, that the estimate for the great railway between Manchester and Liverpool includes £90,000 on the whole, or nearly £3000 per mile, for the price of the ground, which is there so valuable; and that one piece of cutting is to cost £40,000, which adds upwards of another £1000 to the estimate of each mile. The general estimate also includes a large amount for warehouses and locomotive engines. Such are some of the facts on which our statement was founded, and which we conceive fully support it. We know that, at the present moment, the expense of railways would be considerably greater, in consequence of the high price of iron. This, however, is occasioned chiefly by the prospect of the great demand for that article in the formation of such roads, and may be expected to be merely temporary.

METHOD OF CALCULATING MOTIONS ON RAILWAYS.

We may now consider the effect which a steam-engine of given power is capable of producing on a railway. In doing this, it is necessary to consider *the power and weight of the engine, the weight of the waggons, and what they contain; the inclination of the road, and the resistance of the air.* We stated in our former article, that, according to the experiments of Coulomb and others, *the friction of different portions of metal moving on each other, is very nearly the same, whether the velocity is great or small.* To ascertain the truth of these conclusions, in relation to railways, very ingenious experiments have just been made by Mr. Roberts, of Manchester. In these, a small waggon, with four cast-iron wheels, and weighing with its load fifty pounds, was placed on the top of a cast-iron wheel, or drum, a yard in diameter, and six inches broad. The waggon was then attached to one of Marriott's patent weighing machines; and the drum, which was to represent a railway *moving under* the waggon, was put in motion by means of a strap attached to another wheel. By this means, the drum was caused to revolve in such a manner, that its circumference moved with various velocities, from two to twenty-four miles an hour; and, with every velocity, *the effect of the waggon on the weighing machine was uniformly the same;* thus indicating an equal degree of friction, at every

rate of motion. These experiments are quite to the purpose, and seem to be perfectly conclusive; though, to satisfy the sceptical, it would be desirable that they should be repeated on a larger scale. Mr. Roberts is also engaged in experiments, to ascertain the quantity of friction,—an object which is likewise of the first importance; but the results of his investigations are not yet published.

In showing the method of calculating the effect of a steam-engine on a railway, we shall perhaps be more intelligible to ordinary readers, by considering a particular instance, than by a more general, and, in a mathematical point of view, a better mode of proceeding. Let us, therefore, suppose a locomotive engine weighing 6 tons, and capable of holding 1000 lbs. in equilibrium, to be placed on a level railway, and to have attached to it loaded waggons weighing 34 tons, so that the whole weight to be moved may be 40 tons; and let us suppose the friction to be a hundredth part of the load, or 896 lbs. Taking this from 1000 lbs. we get 104 lbs. the force which remains to overcome the inertia, and produce motion. Now, by the theory above stated, this power, if unresisted by the air, would tend continually to increase the velocity, as the friction is the same for every rate of motion; and the velocity might by this means be augmented, in a time that would be easily calculated, to any amount whatever, except in so far as practical obstacles, arising from the construction of the machinery and waggons, might interfere.

In considering the effect produced by the resistance of the air, it is proper to remark, that it is occasioned by the bodies, wheels, and other parts both of the engine and of the waggons, and will depend both on their magnitudes and forms; the resistance to rounded bodies being much less than that which would be sustained by the planes of their bases. Let us resume, therefore, the foregoing example; and let us suppose that the engine and ten or fifteen waggons attached to it, would encounter a resistance equal to that which would be sustained by a plane surface of 100 square feet, which would perhaps not be too great. Dividing the accelerating force, 104 lbs., by this, we obtain a little more than one pound for the resistance on each square foot: and this, according to the experiments of Dr. Hutton, is the same that would be sustained in a motion of about 16 miles an hour. In the case which we have supposed, therefore, the velocity would go on increasing, till it would amount to 16 miles, beyond which there would be no farther augmentation: as the resistance of the air would then exactly balance the accelerating force, and the motion would become uniform. We

have here supposed the air to be at rest: the strength of the wind, however, will often affect the velocity very considerably, unless the power or the load be increased or diminished, as the case may require. A difference also in the resisting surface, in the weight to be moved, or in the amount of the friction, would materially affect the conclusion. Thus, if the resisting surface were 150 feet, the velocity would be reduced to 13 miles: or had the load been increased by 4 tons, while every thing else continued as above, the rate would have been less than 6 miles: or lastly, had the friction been one-ninetieth, while the power and load remained the same as before, the accelerating force would have been so small, that even if the vehicles were put in motion, it could maintain a velocity of only a little more than one mile per hour. All these results are obtained by the mode of calculation pointed out already.

We have thus far considered the railway as perfectly level, which however is rarely the case. To calculate the effect produced by the inclination of such a way, it is necessary to consider, that by the principles of mechanics, any body placed on an inclined plane, tends to descend along it by a force which is the same part of the weight of the body, as the perpendicular height of the plane is of its length. Hence, if we suppose an inclination of one in 300, the moving power would be opposed by a three-hundredth part of the load in the ascent; while in the descent, a like part of the weight in motion would be added to the accelerating force of the engine. On this principle, and those already explained, it might be easily shown, that with this elevation, an engine of the same power and weight as before, and with the same degree of friction, would carry the engine itself and 24 tons up the railway, or the engine and 54 tons down it, with exactly the same velocity as it would carry the engine and 34 tons on the horizontal railway. Hence, if more than 24 tons were required to be conveyed with the same velocity in the former case, the power must be increased; or if less than 54 tons were to be propelled at the same rate in the latter, either the action of the engine must be diminished, or the friction must be increased by locking a wheel, or some similar expedient.

We may now consider in what case *rackwork* would be necessary. Many seem to be apprehensive that, in ascending a railway, even of moderate acclivity, the friction of the wheels on the rails would be insufficient to counteract the tendency of the load to descend by its own weight; and that the wheels, though they would continue to revolve by the action of the machinery, would slide on the rail, and allow the engine and load either to rest or to recede. To enable us to determine

this point, it is necessary to consider that, by the principles of the inclined plane, the pressure of the engine on the rails is to that part of its weight which tends to cause it to descend along the plane, as the base of the plane is to its height; and that the friction of iron sliding on iron, after the motion has commenced, is one-fourth of the pressure. Hence, should the height of the plane be more than one-fourth of its base, or its elevation more than one in four and an eighth, rack-work would be requisite even to carry the engine upward without any load attached; but if the elevation were less, the friction would produce the necessary resistance, and the engine would ascend. If, however, the pressure should be that of an engine of 6 tons, and the weight of the waggons attached were 24 tons, the weight of the engine would be only one-fifth of the whole weight; and, therefore, in this case, to prevent the necessity of rackwork, the height must not exceed one-fifth of what it was in the former case, or in this case, one-twentieth of the base; or which is nearly the same, the rise in the way must not exceed one in twenty, a degree of elevation, which it is scarcely necessary to remark, would never be contemplated for any considerable length in the formation of a railway.

We have thus given examples of the mode in which calculations respecting railways may be conducted on the requisite data; and it will appear that, though from the want of the necessary experiments, it is impossible at present to form certain and definite conclusions; yet, from the theory of friction which we have employed, it will follow, that higher velocities, and greater mechanical advantages may be expected to be obtained by means of railways and locomotive engines, than by any power at present known. Practical difficulties, which no one could foresee, may indeed arise; but is there not an equal chance, that the accumulated mass of knowledge and talent that is from day to day extending the triumphs of practical science, will devise means of obviating these, and even of eliciting advantages at present unforeseen?

The theory which we have been discussing will soon be put to the test of actual experiments, on an adequate scale, and we have no apprehension as to the result. Already, indeed, not to mention some trials of an older date, experiments on the subject have been recently made at Newcastle. In the first set of these, while the load was varied from about 30 to 15 tons, the velocity produced by an eight horse engine, varied from $4\frac{2}{3}$ to $3\frac{3}{4}$ miles an hour, thus falling far short of the expected rate, and affording a temporary triumph to the

opponents of railways, which was seized with an amusing eagerness and satisfaction. The engine used on that occasion, however, was old and imperfect. It was, therefore, found necessary to make other trials with a better one of the same power; and these were attended with results which, in the present stage of the business, must be considered highly satisfactory. A load of 48 tons, 15 cwt. was moved several times, in both directions, along a railway with an inclination of 1 in 840, and in one place 1 in 327. On this occasion, the average velocity was nearly 7, and the greatest 9½ miles an hour. It is also stated, that even this engine was not of the best construction for speed, and that had the railway been good and well fixed, the result would have been higher. Even as the matter stands, we believe, no instance can be produced, in which such a load has been transported on land by any other power with equal rapidity. Such a velocity indeed, is rarely attained for any considerable length of time even by ships at sea, and is at least treble the ordinary velocity of boats on canals. It may be observed also, that according to the principles which have been already explained, the velocity may be augmented to two or three times this magnitude, if the vehicles and machinery be so constructed as to admit, and to be able to bear, the rapidity of the motion.

COMMUNICATION BETWEEN BELFAST AND ENNISKILLEN.

Having said so much on the nature and theory of railways, we shall conclude this article, by again adverting to a subject at which we slightly hinted, in our last Number, the opening of a new communication between Belfast and Enniskillen.

When the making of a canal from Lough Neagh to Lough Erne was proposed, a few years ago, we wished every success to the attempt, and were sincerely gratified to hear of any circumstance that seemed likely to accelerate its formation. We felt then, as we do still, the extreme importance of affording ready means of internal communication to the various parts of the kingdom, and we saw no better mode of effecting this object than by the proposed canal. The measure, perhaps fortunately, was not then carried into effect: no money was expended; and, therefore, though the plan should be abandoned, no private interests would be affected, except in so far as some individuals, from mere locality, or other accidental circumstances, might have been benefited by the proposed canal; and it is still in the power of the public, without the violation of any principle of propriety or justice, to adopt any other mode that may appear preferable. Since, therefore, the science of the day points out a new, and, apparently,

a highly advantageous mode of effecting this and similar objects, *we most earnestly call on the landed proprietors, merchants, manufacturers, and all others who are interested in the intended communication, to pause, and to consider the case in all its bearings, with care and circumspection, before they proceed with the commencement of the intended canal.* We conceive, indeed, that with the prospects which railways present, sanctioned as they are by so many engineers, and by such a proportion of the intelligence of Britain, it would be a public reproach—it would be little short of infatuation, to commence a new canal, without previously making suitable inquiries respecting the expense and the capabilities of a railway; and every person, we are convinced, that would be accessary to such a step, would blame himself ever after, should even half of the expectations that are formed respecting railways be realized.

The communication from Belfast to Enniskillen may be opened, either by a railway from the one to the other; or by a canal from Lough Erne to Lough Neagh, the latter lake being already connected with Belfast by the Lagan Navigation; and the question to be determined is, which of these modes, considered in respect to expense and efficiency, is likely to be of more advantage to the public.

We are aware that the shortness of the distance between the two lakes may be urged as an argument in favour of the canal. If, however, the intended railway between Belfast and Dublin should be carried so far to the west of the present Dublin road, as to pass near Tandragee and Portnorris, which would add very little to the distance, a railway could be extended from it to Lough Erne, which would be but little longer than the projected canal. Such a railway would be excellently situated for accomplishing the ends of such establishments; as it might pass Armagh and other towns, and would intersect a district which is one of the most populous in Ireland, and which would thus be greatly benefited, both in relation to agriculture and manufactures. We are not prepared to suggest the precise line, as that can be determined only by actual survey; but we are inclined to think, that the portion of country of which we have been speaking, would by no means present any considerable difficulties. We are equally unable to state any thing definite respecting the expense; but from what has been said in the preceding part of this paper, we may reasonably conclude that it would be much less than that of a canal, on a corresponding scale. Another advantage of such a railway is, that branches could be readily carried from it to Cookstown, Omagh, Monaghan, Cavan, and

various other places; and, if these were constructed for horses, the expense would be moderate, and the public accommodation great; as a single horse would convey on waggons, according to circumstances, from 4 or 5 to 15 tons, or upwards, of goods, at the rate of 4 miles an hour, to the principal line, where the same waggons, without any injury to the goods by changing them from one vehicle to another, and without labour or loss of time, might be attached to the locomotive engine, and conveyed to their ulterior destination. In case of a canal, on the contrary, branches for lighters, extending from it to such places as those mentioned above, would, in almost every case, be far more expensive, and would want the important recommendation of despatch.

Another objection, of much consequence against the proposed canal, is its connexion with the Lagan Navigation and Lough Neagh. While the Lagan Navigation, like other canals, is liable to interruption from frost in winter; and while in summer, its utility is often, either wholly or partially, suspended for a long period by drought; the advantages which it might otherwise present are greatly counteracted by its partial connexion with the Lagan, as the floods in that river not only, on several occasions, stop the lighters from plying, but also injure the canal. Great delays are also frequently occasioned by contrary winds and stormy weather, on Lough Neagh,—an inconvenience which we believe has been only very partially obviated by the use of a steam-boat. We are informed, indeed, that at present, on account of the delays arising from these causes, goods are very often sent by land carriage to and from Cookstown, and other places, at an expense of £2 or £3 a ton; while the charge on the canal would be only 8s. or 10s.* We are told, also, that the average time of passage by the canal from Belfast to Enniskillen, is estimated at not less than a week; and we have heard that, even in favourable circumstances, the time of passage between Belfast and the Derry side of Lough Neagh, is generally four days. By the railway, on the contrary, on the most moderate calculation, the time of conveying goods or passengers between

* We have seen it lately stated, as an argument in favour of canals in this country, that the carriage (on the Lagan Navigation, we presume) is as cheap as the proposed rates on the Manchester railway. This cheapness, however, is only apparent; as the greater part of the income of the canal proprietors arises from a tax of 4d. per gallon on all the whiskey consumed in Belfast, and a large district of country. This tax, which is generally felt as a partial and heavy impost, yielded, during the last year, some thousands of pounds; and besides this, the proprietors receive, annually, a considerable sum, as an equivalent for a tax, which has been wisely repealed, of 1d. per gallon on all the beer used in the same district. From these facts, it will follow, that the rates of carriage on other canals cannot be expected to be as low as they are at present on the Lagan Navigation.

Belfast and Enniskillen would not exceed twelve or fourteen hours, while five or six hours would be sufficient for the distance between Belfast and Armagh.

It may be supposed that, from the state of the country, railways would not *pay* in many parts of Ireland. The mere paying of a certain per centage, however, on the original shares, should be a very minor consideration, either with landholders or merchants in this country, particularly the former. Should a landed proprietor expend £1000 on such an object, without receiving directly even a shilling in return, he might be repaid, in a manifold degree, by the increased value of his lands; and merchants and traders may be much benefited by the greater export and import of various articles, and by the increased consumption of others. If railways do not pay, however, much less would canals, which, on a corresponding scale, would unquestionably be much more expensive. By railways, also, both travelling and the transmission of goods would be increased in a degree that can never be effected by canals; in the same manner as the intercourse between Belfast and Glasgow is many times greater, since steam-vessels began, a few years ago, to afford new facilities, and new comforts for travelling. By this means, the profits of railways would, in most cases, be much greater than present appearances would at first lead us to suppose; and there is, perhaps, no country where this would be the case in a greater degree than in Ireland, which presents such a harvest of great natural advantages unreaped, and such a numerous population, whose energies, now comparatively dormant, if successfully awaked into useful and profitable action, could soon elevate their country to that rank to which it is entitled among the nations, by its natural resources. We are inclined to think, indeed, that the line we have been recommending holds out a very reasonable prospect of affording an adequate return for such capital as might be judiciously expended in its construction; and, on that account, its formation would probably be undertaken by the Hibernian General Railway Company. By such a line, also, several new districts of country would be opened up; and many gentlemen of property would be interested in its formation, who would doubtless contribute liberally to its funds. It is also reasonable to expect, that the counties through which it would pass would contribute to the expense of its construction, in the same manner as they do to the making of public roads, which are far inferior in utility to railways; and, even if all these means should fail in accomplishing the object, it is likely, from the present disposition of Government towards Ireland, that aid might be granted, in one shape or other, from the public purse.

For farther information on this subject, we must refer to our former article. Some other facts, also, which could not well be comprehended in the limits of this paper, will be found in the scientific matter, at the end of this Number.

We conclude, therefore, by calling the attention of all who are interested in promoting the means of internal communication in this country, to the formation of railways;—not merely of those which would connect Belfast, Dublin, and Enniskillen, but of others which would intersect the fruitful and important districts of Down, Antrim, and other counties of Ireland. Let landlords and tenants consider with what safety and despatch, and at how small expense the grain, butter, pork, live cattle, and other productions of the interior, could be conveyed to Belfast, or other seaports; while building materials, manure, and other articles for the improvement of the country, could be had with equal ease in return. Let merchants and shopkeepers, bleachers and manufacturers, reflect on the facility and despatch with which the various articles that are constantly passing through their hands, may be transmitted from one place to another, as circumstances may require. Let the philanthropist consider what means of improvement would thus be afforded to our country. Give to its population the means of disposing of the productions of their farms to advantage, and of getting in return the articles of convenience and comfort which they would thus be enabled to purchase, and they will be industrious: give them timber and other materials for building, at moderate expense, and they will gradually form the desire of having better dwellings than the miserable hovels in which, to the disgrace of our country, they now generally reside: afford the means of procuring fuel, and other articles necessary for manufactures, and of transporting the manufactured article to its proper destination on moderate terms, and machinery will spring up through the land, and give other employment to the youth of our country, than to lounge in idleness through the day, and to prowl for blood, like the beasts of the forest, in the night. Let these views be considered, and we trust that many individuals of activity and influence will be actuated by the nobler motive of patriotism, and the more powerful one of self-interest, in promoting a project which may bear no inconsiderable share, along with other schemes of improvement, in the renovation of our country, and in promoting the prosperity, comfort, and peace of its inhabitants.

Z. A.